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"AN APPLICATION OF NUDGE THEORY IN CHANGING WASTE SEGREGATION BEHAVIOR IN URBAN HOUSEHOLDS"

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Abstract: The aim of this research is to design nudges to seek solutions to the issue of waste segregation in urban households. The method adopted for this was to create a behavioral map, followed by tracing the barriers in each stage and then formulating the nudges accordingly. The designed nudges were based on the principles of social shaming and loss aversion. Further, the impact of these interventions can be tested using randomized controlled trials. Based on the degree of effectiveness of these interventions, they can be adopted and adapted as policies in the future.

Keywords: Nudge, waste segregation, Social shaming, loss aversion, randomized controlled trials

INTRODUCTION

This research attempts to formulate and analyze the nudges in the context of urban waste segregation. Waste segregation is the process of separately disposing of wet waste and dry waste. This practice has the potential to create positive externalities in the environment. By segregating waste, it can be treated separately, thus minimizing hazards caused to the environment, and ultimately improving people's quality of life and well-being. Segregating waste eases the task of treating biodegradable and non-biodegradable waste. The research focuses on urban household-level solid waste management in the environmental context, aiming to address issues related to waste collection, and disposal within urban areas.

According to a report by the Central Pollution Control Board, in 2020-21, the total solid waste generated in India was 160038.9 tonnes per day, out of which 152749.5 tonnes of waste was collected, and 79956.3 tonnes were treated. The Central Pollution Control Board has predicted that the waste generated by India will increase to 165 million tonnes by 2030. This alarming situation calls for the need for interventions in the paradigm of waste management.

In a world where decisions and choices are often affected by the inertia of the human mind, the act of segregating waste at its source represents a complex challenge in the environment, wherein, bringing about a

change in the environment in the form of certain nudges can help alter the environment to bring about positive changes in human choices. Diwakar Y. (2018) studied waste segregation among households in Powai, Mumbai, wherein the results showed that people tend to not segregate waste in spite of having the awareness and knowledge about the benefits of the same. This leads us to question: How can these environmental features be transformed to nudge individuals and communities towards more sustainable waste management practices?

INTERVENTION DESIGN

In today's world, waste generation is increasing at an alarming rate, causing disarming effects on the environment, leading to widespread pollution, resource depletion, and a looming threat to the delicate balance of our ecosystem. To combat this escalating crisis, innovative solutions are needed that not only address waste management but also engage individuals in sustainable practices of reducing pollution, conserving resources, and promoting subsistence.

Despite the benefits of waste segregation, implementing practice often faces significant roadblocks to human inertia, which involves reluctance or resistance to change disposal habits and embrace sustainable practices. To understand this, we explore system 1 and system 2 of decision-making, as proposed by Nobel laureate Daniel Kahneman. When it comes to the disposal of waste, system 1, which is more intuitive, automatic, and fast, induces humans to discard the waste in one common dustbin by default. Waste segregation, on the other hand, calls for invoking system 2, which is analytical, deliberate, and slower, and requires conscious efforts to overcome the inherent human inertia, thus giving importance to sorting waste and making intentional choices to align with subsistence practices. To understand this, we draw a behavioural map to explore how the decision-making systems interplay in the context of waste segregation. Additionally, we identify and analyze the barriers that come in the way of this decision-making process.

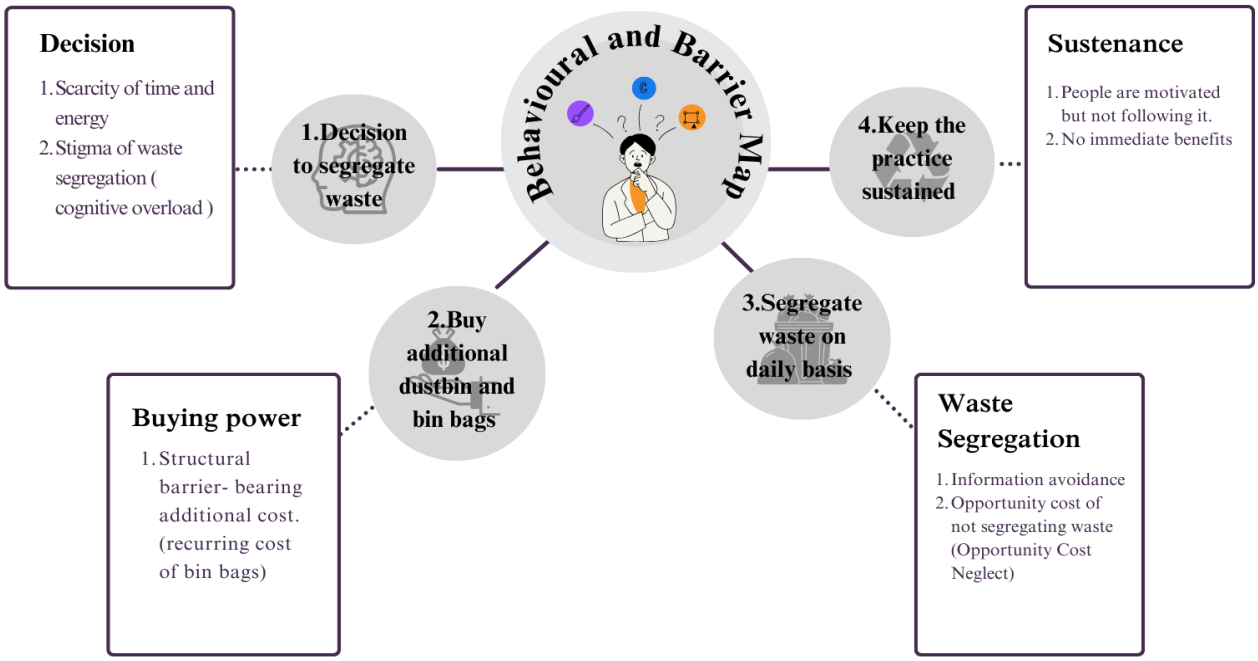

Figure 1: Behavioral map to the flow of barrier map.
Source: Author generated

1. **The decision to segregate waste:** The decision to segregate waste can either be voluntary or it can be imposed by the urban local body as a rule. In our case, let us assume that the decision is voluntary. The barriers that could potentially affect this decision are:
    a. **Barrier of the scarcity of time and energy:**

Individuals, with their limited time and energy, find it challenging to separate waste which tends them to opt for easier and more convincing decisions that are less environmentally friendly. Individuals may prefer disposing of waste together instead of taking time & effort and invoking System 2 to sort waste properly, which leads to higher contamination of recycling waste streams which contributes to adverse environmental issues.

b. The barrier to the Stigma of waste segregation

The presence of negative stigmas due to any sort of religious or cultural sentiments or societal judgments or pluralistic ignorance, individuals may inhibit voluntary waste segregation at the household level.

2. **Buying power:** Individuals have to bear the extra cost of an additional dustbin and the recurring monthly cost of bin bags.

Structural barrier

Individuals are often highly price elastic to decisions for sustainable waste segregation, such as the purchase of necessary tools and equipment. Perception of bearing additional cost because of limited buying power or limited willingness to buy, poses obstacles to proper waste segregation, provoking individuals to opt for shortcuts to disposing of waste altogether leading to adverse environmental consequences.

3. **Waste segregation:** The accuracy rate of waste segregation can be affected due to information avoidance, limited information or negligence. Individuals might not realize the opportunity cost of not segregating waste.

a. The barrier to Information Avoidance

Due to unsureness of the category of certain waste materials, the precision of waste segregation will tend to decrease. This uncertainty arises either due to the dominance of system 1 (since individuals might be used to throwing thrash in a single bin) or due to information ignorance. The seeking of information might be inconvenient, which might lead to avoidance behavior. Due to such laxity, individuals might be less motivated to segregate waste.

b. The barrier to neglecting Opportunity cost

As human beings are not rational, they might consider a cost-benefit analysis of waste segregation in terms of environmental and economic benefits, thus neglecting the opportunity cost of not segregating waste. Individuals may abstain from segregating waste which leads to suboptimal practices, neglecting the spillover effects to reduce the environmental footprints.

4. **Sustenance:** Once the practice of waste segregation is undertaken, it is important to keep the practice sustained and not break it off after a short duration. Lack of persistence might be due to a dearth of immediate benefits or inadequate motivation.

a. The barrier to motivated individuals not following through

Individuals might be motivated, however, that motivation might be insufficient to keep the practice prolonged. Thus, they may segregate waste initially, when the motivation is high, and eventually, as the motivation fades away, the practice might come to a halt. The lack of desire to segregate waste occurs because of individuals' convenience, completing priorities, and lack of understanding on how to effectively segregate waste. The issue is also prevalent when people take advantage of the collaborative actions of society to waste segregation while shirking themselves from their responsibility towards the environment, acting as a "Free Rider" (All You Need Is Nudge, Freakonomics).

b. The barrier to the absence of immediate benefits

Individuals always look for direct rewards or benefits. In the case of waste segregation, the benefits might not appear to be direct, nor can the effect be observed in the short term. The benefits of waste segregation are reaped by not just an individual, but the environment and in turn, the whole of humankind, that too in the long run. The tendency of not caring enough for future generations would lead to non-practice.

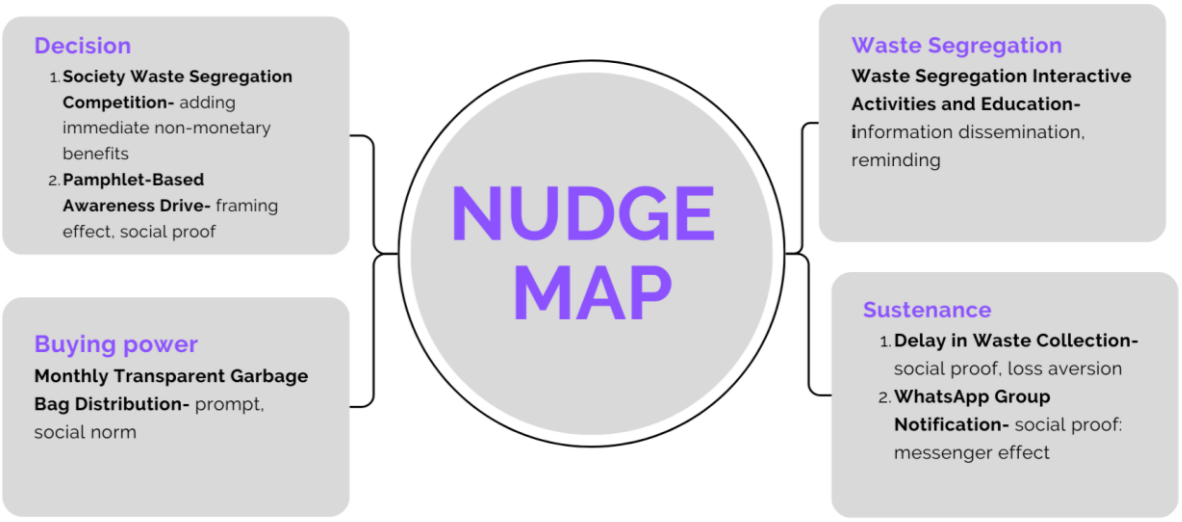

Figure 2: Nudge map
Source: Author generated

NUDGE DESIGN:

Out of all the suggestive nudges, we shall focus on the two non-monetary nudges, regarding the sustenance of waste segregation practices which aim to interact with psychological, social, and environmental factors that influence human behavior, aiming to promote sustainable practices. These practices can have long-term positive effects on the environment, which can help to strike the planetary and societal balance.

a. **Delay in waste collection**

If a household fails to segregate waste, then the municipality will collect waste from that household on the next day. This nudge takes into account the fact that the municipality undertakes door-to-door collection of waste on a daily basis. The identification of waste segregation failure can be facilitated by the use of translucent dustbin bags. This nudge predominantly employs the principle of loss aversion and social shaming to some extent. Households will have to bear with the garbage being at their doorstep for an additional day, which will in turn cause social shaming.

b. WhatsApp group notification

If a household fails to segregate waste, then a WhatsApp message will be put up on the official building WhatsApp group, mentioning the flat number of the household that has failed to segregate waste. This nudge employs the principle of social shaming, by representing that, the daily door-to-door cleaning staff in the community is attentive to waste segregation, if they notice any household failing to segregate waste properly, they shall bring it to the notice of the society committee members, subsequently, the committee shares a message on the WhatsApp group, initiating a form of social accountability aimed to a specific household, which in turn, will not just be a reminder to the household, but will also help to allude bystander effect.

THEORETICAL FOUNDATION

As per Richard Thaler and Cass Sunstein, for an intervention to qualify as a nudge, it must be easy and cheap to avoid. A nudge can neither force people nor offer any sort of economic incentive (Murayama et al., 2023). Hence, the attempt of this research was to not include any rules or fines because these tend to be rigid in nature and there remains no option to back out at any time (Loan et al., 2023). When policymakers use nudges in the environmental domain, those nudges are called ‘green nudges’. Large-scale dumping of solid waste material into landfills has negative effects not just on residences but also on the entire humankind and contributes to global warming. To use waste as a resource for various productive processes like recycling, composting, and conversion to fuel, efficient management of waste is required. For this, policymakers can use nudges to promote behavioural changes for strengthening waste segregation at the household level (NITI Aayog, 2021). In eight cities in China, a nudge was given for waste segregation. They followed the system of waste disposal in community bins. The urban local body replaced the single community dustbin with four dustbins of different colors. Blue dustbins were for recyclable waste, green for kitchen waste, red for hazardous waste, and yellow bin was meant for unsorted waste. It was a voluntary practice and if the households did not want to segregate waste, they had the option of disposing of their unsorted waste in the yellow dustbin. This practice

was based on social norms and was expected to have spillover effects on the people of the community (Zhang et al., 2020).

1. **Delay in Waste Segregation (Loss aversion)**

The nudge of delay in waste segregation is based on the principle of loss aversion. A nudge based on the concept of loss aversion establishes the fact that a loss of a particular amount has the potential to create a greater impact on the human mind than a benefit of the same amount. Beermann et al. (2022) designed two loss aversion nudges to encourage pro-environmental behavior. These nudges helped to bring about sustainable heating behavior among residents.

2. **Whatsapp group notification (Social norms)**

Whatsapp group notification is based on the principle of social shaming and reminders. Wadhera et al. (2021) observed that sending weekly reminders to people regarding waste segregation helped to recapture their attention regarding the issue and had a positive impact on strengthening their resolve regarding segregating waste. Based on the study of Schultz et al. (2007) in "The constructive, destructive, and reconstructive power of social norms", Amsterdam a city in the Netherlands took the use of social norms messaging to simply remind people that "most people in Amsterdam recycle" which generated a conform norm and led to a sense of belonging with their community, in turn, helped the city to achieve 5% increase in recycling rates through effective social norms messaging.

CONTEXT SPECIFICS

Behavioral economics has emerged as a field of study providing theoretical insights into human behavior, especially in the context of judgment and making decisions. Within this context, the concept nudge has gained particular attention. Taken as an intervention, nudges play an innovative role in influencing individuals to waste segregation in a subtle automatic way, leading to a pro-environmental spillover effect.

The waste management system has garnered widespread attention in India after the initiation of the Swachh Bharat Mission. Coordination at all levels of the government, coupled with massive citizen participation has helped to bring in positive results since the inception of the mission in 2014. In 2016, NITI Aayog decided to set up a 'nudge unit' that would work towards taking into account behavioural insights for policy recommendations for several government schemes and programs, the Swachh Bharat Mission being one of them. Under the ambit of the Swachh Bharat Mission, several initiatives were undertaken at various levels. For instance, at the national level, the Swachh Survekshan Awards were brought in to create a competitive atmosphere among cities. At city levels, waste segregation practice was made mandatory by the urban local bodies of cities like Mumbai, Indore, etc. The second phase of the Swachh Bharat Mission (Urban) was released, aiming to make the cities in India garbage-free.

1. **Delay in waste segregation**

This nudge based on loss aversion and social shaming is not a completely novel approach. It has been formulated by tweaking a rule that was imposed by some of the civic bodies in the Mumbai Metropolitan Region. After the Swachh Bharat Mission came into force, several cities in India undertook the practice of waste segregation. This practice was rather made mandatory by the civic bodies and punitive measures were imposed upon failure to do so. For instance, Brihanmumbai Municipal Corporation (BMC) and Indore Municipal Corporation (IMC) started imposing fines on households that did not segregate waste. Kalyan Dombivali Municipal Corporation (KDMC), on the other hand, did not bring the monetary aspect, but it said that the civic authorities would not collect waste from those households that do not segregate waste and that their garbage will remain at their doorstep. This intervention was tweaked in order to make it a nudge since a nudge cannot be a compulsion for anyone and there needs to be an option to opt out at any time. The loss aversion dimension of the rule of the KDMC was modified to make it into a suitable nudge, but the social shaming dimension holds true.

2. **Whatsapp group notification**

The use of social norms as a nudge through the medium of messaging tools was employed in the previous intervention aimed at promoting successful waste segregation practices in urban societies. This intervention sought to socially align people with the norm to segregate waste, where individuals are socially inclined towards waste segregation. This practice of leveraging social tools was implemented in the Netherlands, where social messaging was used to encourage people to align themselves with waste segregation. The

practice of socially aligning people to waste segregation was enforced by certain civic bodies in Indian societies through punitive measures intended to serve as a form of social shaming. For instance, Wadhera et al. (2021), stated that people tend to adopt more socially segregated practices when they are socially pumped in society. The intervention was designed to nudge people by creating a sense of social pressure and conformity within the dimensions of social proofing.

TARGET DEMOGRAPHICS:

The designed nudges aim to target households in the societies and colonies in urban areas in India. Since each society or colony would come under the ambit of their respective societal committees, coordination with the urban local body regarding these waste management practices would be easier. The intervention equips strategies to employ effective waste segregation practices in the form of social proof and loss aversion and aims to ensure sustainability and long-term effects among the targeted demographics. The intervention focuses on promoting sustainable waste segregation practices and reducing indiscriminate waste disposal practices in the environment.

INTERVENTION TESTING

Randomized Control Trials (RCTs) are a testing approach that is used to test the efficacy of the designed interventions. Under this approach, the efficacy of interventions is tested by comparison between a control group and treatment group(s). An RCT helps to test the elements of the intervention, and the extent to which it achieves its objectives by means of a quantifiable outcome variable. Breaking down the RCTs has three vital components: randomization, a control setup, and a trial approach. Randomization is essential in order to avoid selection bias. By having a control setup, we keep some variables constant. RCTs help us to establish causality between variables, ruling out chances of mere correlation. For the purpose of our study, we shall use the cluster RCT approach, wherein there are multiple treatment units, in the form of urban societies and colonies, however, the intervention is taking place at the household level.

STEPS FOR TESTING:

1. **Research problem and hypothesis framing**

The research question for the intervention is: has the rate of waste segregation increased after implementing the designed nudges? This will help us to study the extent of the impact of the nudges on the waste segregation behavior of people and also check as to which of the two nudges has the potential to create a greater impact. In order to check the sustenance of waste segregation behavior among people, a time period of six months is selected for the testing of intervention. This will ensure that our nudges have reached a stage of maturity and hence the testing can show appropriate results.

The hypothesis for the testing of the intervention:

H0: There is no significant difference in the rate of waste segregation among the control group and treatment group.

H1: The rate of waste segregation is higher in the treatment groups than in the control group due to the implementation of nudges.

2. **Homogeneity among groups**

For testing the hypothesis, homogeneous groups (control and treatment) are selected. This is done so that the homogeneous attributes of the control group and treatment group get canceled and only the net effect of the intervention can be studied by the researcher. Hypothetically, our chosen groups are three neighborhoods that have homogeneous attributes in the following ways:

1. **Size:** The number of households and societies should be the same for the chosen groups. Hypothetically, the number of societies in each group is 500, with each society containing the same number of households.
2. **Income level:** The households in each group belong to the average middle-class socioeconomic background.
3. **Education level:** The education level of the people living in the neighborhood is graduation.
4. **Occupation status:** The people in the neighborhood work in either the secondary or tertiary sector.
5. **State of development:** The neighborhoods are situated in developing cities having relatively average living conditions.
6. **Government support:** The level of government support provided in the three neighborhoods is equal in terms of the provision of collection of waste by garbage vehicles, and by equipping community bins at regular intervals.

3. Randomization of sample

To test the hypothesis, we randomly selected 250 societies from each of the three neighborhoods and distributed them randomly to form one control group and two treatment groups. The random sample taken for testing is unbiased which will ensure the accuracy of the results by eliminating any sort of skewness. In order to prevent contamination from the spillover effect, an efficient review mechanism or monitoring system would be beneficial.

4. Intervention formation: Breakdown of the control group and treatment group

The control group is not revealed to the experimental treatment or the intervention being studied. The control group serves as a baseline or benchmark to compare and evaluate the effectiveness of the intervention. The purpose of the control group is to provide an angle of comparison to study the impact of efficacy of the intervention on the treatment group. By observing and comparing the outcomes of the treatment group to the control group, the magnitude of the effectiveness of the intervention can be evaluated.

The treatment group containing the sample of people is subjected to the intervention under study. The outcomes and behavior of the treatment group are compared to the control group to study the effectiveness of the intervention. In this case, treatment group 1 receives only the WhatsApp group notification intervention, whereas treatment group 2 receives both interventions, that of WhatsApp group notification as well as delay in waste collection.

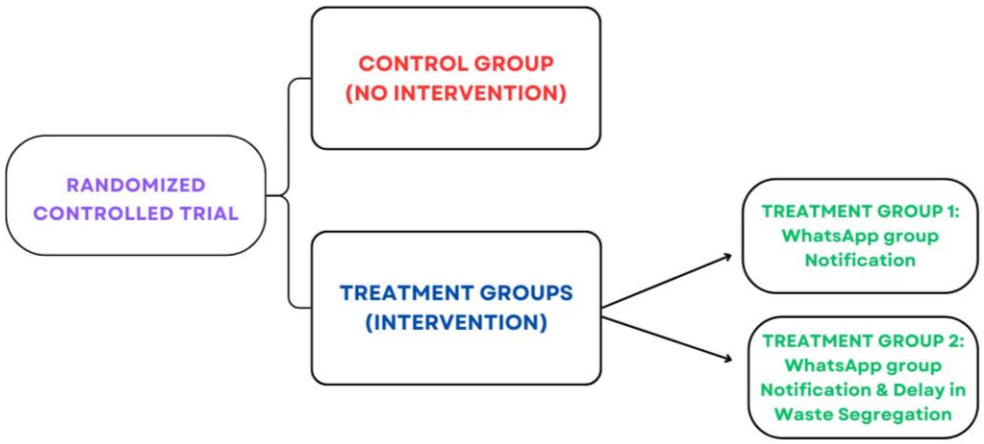

Figure 3: Randomized controlled trial: Control and treatment group
Source: Author generated

5. Measuring outcome variable

In order to measure the effectiveness of the nudge, a quantifiable outcome variable is necessary. In this case, the outcome variable is the number of households that have been successful in segregating waste over the period of six months. In order to find out the extent of efficacy of the nudges, regression equations have been formulated:

a. Number of households segregating waste = □1 + β WhatsApp notification

In this equation, the number of households segregating waste is a quantitative dependent variable and WhatsApp notification is a qualitative independent variable, where:

Whatsapp notification = 1 if the Whatsapp group notification is given
= 0 if the WhatsApp group notification is not given.

□1 will be the number of households segregating waste even in the absence of the nudge and β will be the magnitude of the effect of the WhatsApp group notification nudge on the waste segregation behavior of the people.

b. Number of households segregating waste = □2 + β1 WhatsApp notification + β2 Delay in the collection

In this equation, the number of households segregating waste is a quantitative dependent variable along with two qualitative independent variables, which are WhatsApp notifications and delay in waste collection.

Whatsapp notification = 1 if the Whatsapp group notification is given
= 0 if the WhatsApp group notification is not given.

Delay in waste collection = 1 if the WhatsApp group notification is given
= 0 if the WhatsApp group notification is not given.

□2 will be the number of households segregating waste even in the absence of the nudges. β1 will be the magnitude of the effect of the WhatsApp group notification nudge on the waste segregation behavior of the people and β2 will give the magnitude of the effect of the delay in waste collection nudge on the waste segregation behavior of the people.

6. Type of experiment: A framed field experiment

To test the intervention design, a framed field experiment is conducted where the subjects are real people who are aware of the experiment being conducted, with a behavioural environment that is of their homes (field). The chosen context is taken to be framed as the natural field experiment violates ethical norms and deceives the people subjects under study.

7. Outcome and findings

For measuring the outcome, a subsequent period of 6 months is taken into consideration, after the implementation of the nudge in testing groups, this is done to quantify the results generated by households. The outcome obtained from the testing acts as a base to evaluate the effectiveness of the nudge in both treatment cases. To evaluate the effect of a single nudge versus the combined effect of both nudges we take: For treatment group 1, in the absence of a Whatsapp notification nudge, the number of households segregating waste will be □1. After implementing the nudge, the number of households segregating waste will be □1+β (which should be greater than □1). For treatment group 2, in the absence of both the nudges, □2 number of households will segregate waste. When both the nudges are implemented simultaneously, □2+β1+β2 number of households will segregate waste. If □2+β1+β2 > □1+β then we can say that the combined effect of both nudges is better than the effect of a single nudge.

For checking the statistical significance of the coefficients, their respective p-values shall be evaluated. With the standard level of significance being 5%, the coefficients with p-values less than 0.05 shall be considered statistically significant. If our nudge is effective enough (the statistically significant coefficient), then we shall reject the null hypothesis and accept the alternate hypothesis that the rate of waste segregation is higher in the treatment groups than in the control group due to the implementation of nudges.

From analyzing the testing of the control group versus the treatment group, it is expected that after the implementation of the intervention on treatment groups, there was a significant increase in the waste segregation practices in the household, whereas, in the control group, the situation remains more or less unchanged. The control group serving as a counterfactual, shows that, if the implementation of intervention on proper waste segregation practices had been followed, the positive effect on the community would have been significantly higher.

CONCLUSION:

As waste management is the call of the hour, effective interventions are required to induce waste segregation practices in societies that lead to positive effects on the environment. A nudge can be used as an effective policy-making tool to render desired changes in people's behavior, by preventing the barrier to sustenance. For this, nudges in the form of loss aversion and social proof are required that encourage people to segregate waste properly. Through previous studies, it is evident that fear of loss and social shaming have been successful in bringing a change in people's behavior. This can be explained by the 'punishment tool', which has proven to be useful in the climate change scenario, which can be observed through the example of the Paris Accord- the countries who do not cooperate in terms of pro-environmental behavior will be punished via tariffs. (All You Need Is Nudge, Freakonomics). Human Development Report 2020, states that "Social norms are powerful determinants of people's choices." The government, acting as a confounder often uses monetary tools as interventions, which are punitive in nature.

On the contrary, our attempt was to formulate non-monetary nudges, designed in a way that has a positive impact on the behavior of the people in the society leading to a spillover effect on the environment. By relying on a participatory approach, pro-environmental practices can promote sustainability, reinstate the environment, and lead to overall well-being by diminishing ecosystem losses. Context-specific nature-based solutions with a bottom-up approach can be translated at higher levels, leading to positive externalities. Implementing nudges to effective waste segregation can lead to increased awareness of environmental problems, as individuals become more aware of their habits to waste management. This practice also fosters

a sense of community responsibility and engagement that results in proper resource management and can have a positive economic impact.

RCT has been used to establish a causal relationship between the designed nudge and the outcome variable, that is the number of households segregating waste successfully. The result formed by testing RCTs into intervention showcases that the nudge is effective. Drawing from these positive results, the designed nudges can later be implemented at a macro level as a policy. The Human Development Report 2020 mentions how we are living in unprecedented times, where human activities are shaping up the planetary aftermath. A transformation is required, which can be brought about by people's agency and by empowering them to undertake actions required to strike the ecological balance. Looking at the bigger picture in terms of climate change, individual-level nudging coupled with systemic handholding by both the public and private sectors will be required to quash the existing anomalies.

"We can't solve climate change with nudging, but we can't solve it without nudging"
~Richard Thaler

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